

## SECTION 15800

### AIR DISTRIBUTION AND EXHAUST

#### PART 1 GENERAL

##### 1.1 SUMMARY

###### A. Scope

1. Provide labor, materials and equipment to provide air distribution and exhaust systems, including accessories as necessary to provide properly functioning installations.

###### B. Description Of Systems

###### 1. ABOVEGROUND SYSTEMS

- a. Galvanized sheet metal ductwork, 2" WG, positive or negative, except as otherwise indicated on the DRAWINGS, minimum Seal Class B, per SMACNA HVAC Duct Construction Standards.
- b. Aluminum sheet metal ductwork, 2" WG, positive or negative, except as otherwise indicated on the DRAWINGS, minimum Seal Class B, per SMACNA HVAC Duct Construction Standards.
- c. Acoustically lined galvanized sheet metal ductwork, 2" WG positive or negative, except as otherwise indicated on the DRAWINGS, minimum Seal Class B, per SMACNA HVAC Duct Construction Standards.

###### C. Related Work Specified Under Other Sections

1. Division 13 Section "Environmental Systems Control." including duct probe access fittings.
2. Division 15 Section "General Mechanical Requirements."
3. Division 15 Section "Environmental Equipment."
4. Division 15 Section "Testing and Balancing".
5. Division 16 Sections "Electrical Work."

##### 1.2 QUALITY ASSURANCE

###### A. Reference Standards

1. Standards of SMACNA:
  - a. HVAC Duct Construction Standards (DCS), Second Edition, 1995.
  - b. Manager's Guide for Welding.
  - c. Testing, Balancing and Adjusting of Environmental Systems.
2. NFPA 90A, Air Conditioning & Ventilating Systems.
3. NFPA 91, Blower & Exhaust Systems.
4. ACCA, Air Conditioning Contractor's Association.
5. ACGIH "Manual of Recommended Practice for Industrial Ventilation".
6. ADC, Air Diffusing Council.
7. ASHRAE Fundamentals Handbook and Product Directory.
8. AISI, American Iron and Steel Institute.

9. ANSI, American National Standards Institute.
10. ASTM, American Society for Testing and Materials.
11. AWS, American Welding Society.
12. FS, Federal Specifications.
13. NBS, National Bureau of Standards.
14. Wherever the words “should”, “recommended”, “it is recommended”, “preferred” or “must” appear in the text of the referenced standards, interpret them as the word “shall”, to indicate mandatory conformance. Where the words “can” and “may” are similarly used in conjunction with an option which would result in superior quality or strength construction, interpret them as “shall”.

### 1.3 SUBMITTALS

- A. Refer to Division 15 Section “General Mechanical Requirements” for applicable requirements.
- B. Submit shop drawings of ductwork and plenums. Show details of joint construction, supports, reinforcement, access doors, fitting configuration and accessory installation for construction where these are field conditions or specified options.
- C. Submit a schedule of proposed air diffusion devices, indicating type, location, air quantity, neck or jet velocity, pressure drop, throw and diffusion range. Identify air diffusion devices using CONTRACT DRAWING DESIGNATIONS. Include sound data for supply air diffusion devices in terms of sound power level in octave bands 2 through 8, and NC Index for the capacity range of the device. Where no room attenuation is indicated, 8 dB shall be assumed. Where no noise criteria data is indicated, NC-40 shall be assumed.
- D. Furnish data regarding loads and forces imposed on building structure by proposed work sufficiently in advance of the required work to permit analysis of structure for proposed loads and forces.
- E. *Test report [R]*: Submit test reports of each system as described under FIELD QUALITY CONTROL.

## PART 2 PRODUCTS

### 2.1 DUCTWORK MATERIALS

#### A. Sheet Metal - Galvanized

##### 1. Sheet Metal:

Mill galvanized steel of lock forming quality per ASTM A 653/A 653M; Coating Designation G-90 (Z275).

2. Reinforcing and Supports: Structural steel per ASTM A 36; Mill galvanized per ASTM A 123. Fabricated sheet steel per ASTM A 653/A 653M, Coating Designation G-90 (Z275). Equivalent, proprietary design rolled steel structural support systems may be used in lieu of mill rolled structural steel.
  3. Bolts and Fasteners: Carbon steel; zinc coated per ASTM A 153.
  4. Gaskets: Chloroprene elastomer, 40 Durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.
- B. Sheet Metal - Aluminum
1. Sheet Metal: Aluminum alloy per ASTM B 209, Alloy 3003, Temper H-14.
  2. Reinforcing and Supports: Mill extruded aluminum shapes conforming to ASTM B 221 or galvanized steel shapes per ASTM A 36 and mill galvanized per ASTM A 123.
  3. Gaskets: Chloroprene elastomer, 40 Durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.
- C. Sheet Metal - Galvanized Spiral
1. Duct and fittings: Galvanized sheet steel lock forming quality per ASTM A 653, Coating Designation G-90, factory fabricated, lock seam or welded design per SMACNA (HVAC Construction Standards)(Round Industrial Duct Constructions Standards)(Rectangular Industrial Duct Constructions Standards).
    - a. United McGill Corp.
    - b. Semco Mfg. Co.
- D. Brazing Materials
1. Silicon bronze: Per AWS A5.6 or A5.7.
- E. Welding Materials
1. Welding materials: Refer to SMACNA "Manager's Guide for Welding" for applicable requirements.
- F. Packing
1. Mineral fiber: Per FS HH-I-558, Form B, Class 8.
- G. Caulk
1. Elastomer caulk: UL Listed and per NFPA 90A.
    - a. Benjamin Foster No. 30-02.
    - b. McGill "Duct Sealer", Div. of United McGill Corp.
    - c. Miracle Adhesives Corp. "Miracle D615".

- H. Inorganic Zinc Rich Paint
  - 1. *Inorganic zinc rich paint [P]*:
    - a. Carboline, “Carbo-Zinc”.
    - b. Tnemec.
    - c. Koppers.

## 2.2 DUCTWORK SPECIALTIES

### A. Acoustic Lining

- 1. Duct Acoustic Lining: Provide acoustic lining, per SMACNA HVAC Duct Construction Standards, in sheet metal ductwork where indicated. Minimum 1 inch thickness, except as otherwise indicated on DRAWINGS. Increase size of ductwork to maintain original inside design dimensions. Density of the insulation including surface coating or facing shall be minimum 1.5 pounds per cubic foot, maximum 2 pounds per cubic foot. Liner shall be impregnated on the surface exposed to air stream per ASTM C 1071 and NFPA 90A. Air stream side of the liner shall withstand air velocities of 4000 FPM without delamination or erosion.

#### DENSITY, PCF

- |  |            |
|--|------------|
| a. Owens-Corning “Quiet R” (Flexible).       | 2          |
| b. Manville “Linacoustic” (Flexible).        | 1-1/2      |
| c. Certainteed Corp. “Ultralite” (flexible). | 1-1/2 or 2 |
| d. Knauf Duct Liner M (Flexible).            | 1-1/2      |

### B. Acoustic Lining Accessories

- 1. *Adhesive [P]*:
  - a. Foster 85-00.
  - b. Insul-Coustic Div., Berma Products Corp.
  - c. Vimasco Corp.
- 2. *Sealants and edge sealing mastic [P]*:
  - a. Foster 40-10.
  - b. Insul-Coustic Div., Berma Products Corp.
  - c. Vimasco Corp.
- 3. Mechanical fasteners: Per (HVAC Duct Construction Standards)(Round Industrial Duct Constructions Standards)(Rectangular Industrial Duct Constructions Standards).

### C. Duct Probe Access

- 1. Duct probe access: Provide plugs with threaded or twist-on cap fittings.
- 2. Duct probe access fittings will be provided as part of the WORK under another CONTRACT.

### D. Flexible Connectors - For Indoor Use

- 1. *Fabric [P]*: UL Listed and conforming to NFPA 90A, 30 ounce, waterproof and non-combustible, air-tight, glass fabric double coated with fire-retardant polychloroprene. Minimum clear width, not including clamping section, shall be 6 inches.
  - a. Ventfabrics, Inc., “Ventglas”.

E. Flexible Duct

1. Flexible duct connectors: Rated and tested under UL-181 Class 1 Material, and comply with NFPA 90A. Maximum length shall be 5 feet unless otherwise indicated.
2. Galvanized spring steel or aluminum spiral helix and glass cloth duct: Insulated with fibrous glass and vapor barrier jacketing to provide a C factor of 0.23. Working pressure 1-1/2" WG. Diameter as indicated.
  - a. Owens-Corning "Fiberglas" INL-25.
  - b. Flexmaster Type 5.

F. Flexible Duct Fittings

1. *Flexible duct fittings [D]*: Galvanized steel, twist-in design with damper. Size as indicated.
  - a. Cleavaflex, Spin-Collar.
  - b. Flexmaster Type FLDE.

G. Manual Dampers Up To 2" WG

1. *Balancing dampers [P]*: Butterfly, or multi-blade type per SMACNA HVAC Duct Construction Standards and as specified, to balance each respective main and branch duct under operating conditions encountered.
  - a. Round Ducts: Provide single blade type for sizes up to 12" dia., and multiblade type for sizes 13" dia. thru 50" dia.
  - b. Rectangular Ducts: Provide single blade type for sizes 6" width x 4" height thru 12" width x 10" height, and multiblade type for sizes 12" width x 12" height and larger.
    - 1) American Warming & Ventilating, Inc., Model VC.
    - 2) Pottorff.
    - 3) Ruskin, Model MD35.
    - 4) C.E. Sparrow Co.
2. Indicating quadrant regulator: Equip dampers with regulator with an external locking feature adjustment. Where damper rod lengths exceed 30 inches, furnish a regulator at each end of damper shaft which shall have two end bearings. For insulated ductwork regulators shall have elevated dial above insulation thickness.
  - a. Ventfabrics Inc.
  - b. Young Regulator Co.
  - c. American Warming & Ventilating, Inc.
3. *Damper rod and end bearings [P]*: For dampers.
  - a. Ventfabrics, Inc., "Ventlok No. 607".
  - b. Young Regulator Co.
  - c. American Warming & Ventilating, Inc.
4. *Regulator [P]*: Concealed for dampers regulated through ceilings, box mounted in ceiling with plain cover.
  - a. Ventfabrics, Inc. "Ventlok No. 666".
  - b. Young Regulator Co.
  - c. American Warming & Ventilating, Inc.
5. Where ceiling is removable construction, install regulators above ceiling, and mark location on ceiling in a manner approved by the ARCHITECT-ENGINEER.
6. Make splitter damper minimum sheet metal gage two gage numbers heavier than duct in which installed, i.e., 20 gage splitter in 22 gage duct, up to 16 gage maximum. Make

hinges full length piano type of 1/8 inch thick door type. Make minimum gage of balancing damper sheet metal equal to: Up to 18 inch blade length parallel to pivot rod - 20 gage; 19 to 48 inches blade length parallel to pivot rod - 16 gage. Verify duct gage before fabrication. Furnish full length damper shaft which extends beyond damper blade. Use 3/8 inch square shaft for damper lengths 21 inches and larger. To prevent damper vibration or slippage, furnish adjustable support rods at damper blade end with locking provisions for installation external to duct.

H. Pressure Relief Damper

1. *Pressure relief damper [P]*: Counterbalanced or spring-loaded damper with blades linked together to open at indicated preset pressure.
  - a. American Warming and Ventilating Co.
  - b. Ruskin Mfg. Co.

I. Pressure Relief Access Door

1. *Round duct type access section [P]*:
  - a. United McGill Corp. Type AR-W.

J. Access Doors

1. Duct access door: Construct per (HVAC Duct Construction Standards)(Round Industrial Duct Constructions Standards)(Rectangular Industrial Duct Constructions Standards), minimum size 10 x 16 inches unless otherwise precluded by duct dimensions. Insulated doors shall be double panel type.
2. Commercial equivalent doors: May be used on approval of proposed product samples.
  - a. Air Balance Inc.
  - b. American Warming and Ventilating Inc.

K. Gravity Backdraft And Relief Dampers

1. *Frame [P]*: Construct of not less than 1-1/2 by 4 inch reinforced 16 gage galvanized carbon steel. Mount frames and mullions in place and seal with elastomer calking. Fabricate blades with maximum width of 9 inches and maximum length 36 inches. Blade material 16 gage galvanized steel, 14 B & S gage 6063 or 5052 alloy aluminum or 18 gage AISI 18-8 stainless steel. Furnish blades with mechanically retained seals and 90 degree limit stops.
  - a. American Warming and Ventilating Inc.
  - b. Ruskin Mfg. Co.
2. *Counterbalanced dampers [P]*: With blades linked together to open not less than 30 degrees on 0.05" WG differential pressure. Furnish shaft bearings of graphite impregnated nylon or oil impregnated bronze. Equip dampers with fixed and adjustable counterbalancing weights.
  - a. American Warming and Ventilating Inc.
  - b. Ruskin Mfg. Co.

- L. Fire Dampers And Wall Sleeves (Collars)
  - 1. *Parallel blade type fire dampers [P]*: Constructed and labeled per, UL 555 Class “B” rating. For link loads in excess of 20 pounds, furnish UL Listed quartzoid links. Fabricate operating element for housing external to air stream. Fabricate wall collars per UL 555.
    - a. Ruskin Mfg. Co. Model FD-35 Series.
    - b. Air Balance Inc.
    - c. Pottorf.
  - 2. *UL Labeled curtain type fire damper* Constructed and labeled per, UL 555 [P]: Store curtain out of air stream.
    - a. Air Balance, Inc. Type B.
    - b. Ruskin Mfg. Co. Model IBD-2 Style B.
    - c. Pottorf.
    - d. Air Balance, Inc. Type B.
    - e. Ruskin Mfg. Co. Model IBD-2 Style B.
    - f. Air Balance, Inc. Type A.
    - g. Ruskin Mfg. Co. Model IBD-2 Style A.
    - h. Pottorf.
    - i. Air Balance, Inc. Type C.
    - j. Ruskin Mfg. Co. Model IBD-2 Style C.
    - k. Pottorf.
- M. Automatic (Power Operated) Dampers
  - 1. Automatic dampers: Except where integral with packaged units furnished as specified in 13800 Series SECTIONS for installation as part of the WORK of this SECTION.
- N. Smoke Dampers
  - 1. Smoke dampers: Furnished as specified in Division 13 Series SECTIONS for installation as part of the WORK of this SECTION.
- O. Turning Vanes For Right Angle Elbows And Branch Tees
  - 1. Turning vanes shall be provided in all right angle elbows and branch tees. Turning vanes shall be factory fabricated, true airfoil design with smoothly rounded entry nose and extended trailing edge, mounted on pre-punched sidepieces of the same make as the vanes proper. Spacing of vanes shall be as defined by sidepiece punching but in no case shall spacing exceed 2-1/2 inches. Single sheet-turning vanes and shop-fabricated turning vanes are prohibited.
  - 2. Where right angle elbows have an outlet size dimension different from inlet size or a branch tee fitting has unequal outlets requiring the turning vane assembly to be installed in duct fitting at an angle other than 45 degrees, sidepieces of split rail design shall be provided to permit adjusting vanes to required airflow configuration.
    - a. Aero/Dyne Company H-E-P.
- P. Short Radius Elbows (Rectangular Duct)
  - 1. Wherever obstructions necessitate a throat radius which is less than duct width and air velocity exceeds 1000 FPM fabricate splitter vanes as smooth single elements per SMACNA HVAC DUCT CONSTRUCTION STANDARDS Fig. 2-6.

Q. Air Diffusion Devices

1. General Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics. Provide ADC certified manufacturer's standard devices.
  - a. Provide plaster frames for units installed in plaster ceilings.
  - b. Provide gaskets for supply terminal air devices mounted in finished surfaces.
  - c. Install wall mounted supply registers 6 inches below ceiling unless otherwise indicated.
  - d. Provide aluminum air diffusion devices with anodized exposed-to-view surfaces. Provide steel air diffusion devices with specified finish. Where aluminum components are mixed with steel components, finish shall be as specified for steel air diffusion devices. Finish and color shall be as selected by the ARCHITECT-ENGINEER. Provide air diffusion device interior surfaces, including blank-offs, with black matte finish.
  - e. Provide supply diffusers with damper and equalizing grid. Damper shall be extracting splitter type unless otherwise specified.
  - f. Air volume and pattern adjustments shall be made from the face of the device.
2. *Diffusers [P]*: Provide the following:
  - a. Type SD-1: Supply diffuser, aluminum, square pattern and square neck with inner core assembly consisting of fixed deflection louvers with horizontal discharge pattern as indicated, adjustable vanes to provide full vertical to horizontal projection, combination damper and equalizing grid, and white baked enamel exterior surface finish.
    - 1) Titus Model TDCA-AA.
    - 2) Anemostat.
    - 3) Krueger.
    - 4) Price.
3. *Registers [P]*: Provide the following:
  - a. Type SR-1: Supply air register, prime coated, pressed steel with opposed blade dampers. Units constructed as double deflection type, with adjustable face bars parallel to short dimension, opposed blade dampers, adjustable by key or lever from face.
    - 1) Titus Model 300-RS-S.
    - 2) Anemostat.
    - 3) Krueger.
    - 4) Price.
4. *Grilles [P]*: Provide the following:
  - a. Type RG-1: Same as specified for SD-1, except opposed blade damper and adjustable vanes are not required.
  - b. Type RG-2: Steel, return grille, fixed face bars with baked, off-white enamel finish. Provide unit with fixed horizontal face bars set at an angle of approximately 45 degrees down and parallel to long dimension.
    - 1) Titus Series Model 350RL.
    - 2) Anemostat.
    - 3) Krueger.
    - 4) Price.



## 2.3 DUCT SUPPORTS

- A. Refer to Article “DUCT AND EQUIPMENT SUPPORT SYSTEM”.

## PART 3 EXECUTION

### 3.1 DUCTWORK FABRICATION

- A. Fabricate sheet metal construction per “REFERENCED STANDARDS”, except as modified and supplemented by this SPECIFICATION.
- B. Fabricate ductwork to prevent failure under pressure or vacuum created by fast closure of ductwork devices. Provide leaktight automatic relief devices where indicated.
- C. Fabricate necessary offsets and transformations to avoid interference with the building construction, piping, or equipment. Make easements (streamliners) for duct obstructions per SMACNA HVAC Duct Construction Standards.
- D. Where ducts pass through walls and floors, finish wall openings with metal trim strips, and curb floor openings where indicated. Use metal sleeves; wood frames are not permitted.
- E. Where ducts pass through fire rated walls and floors, or walls and floors of buildings more than two stories high, fill voids and cavities around wall and floor penetrations with firestopping and smoke sealing materials to maintain the required fire-rated condition of substrate.
- F. Duct dimensions on DRAWINGS are interior dimensions. Dimensions shall be increased as necessary to compensate for liner thickness.
- G. Where rectangular sheet metal ductwork is indicated, on approval by the ARCHITECT-ENGINEER, equivalent capacity round ductwork may be substituted.
- H. Ducts exhausting shower rooms shall be aluminum sheet metal soldered watertight and pitched to the shower-bathroom registers.
- I. Repair galvanized surfaces damaged by method of duct fabrication by the application of zinc rich paint per manufacturer’s instructions.
- J. Crossbreak or bead rectangular sheet metal ducts, 19 inches wide or larger, which have more than 10 square feet of unbraced panel (including externally insulated ducts). Where sheet metal is not crossbroken or beaded, increase sheet metal gage by four gage numbers, i.e., 24-gage crossbroken equal to 20 gage not crossbroken.
- K. Where ducts pass through fire-walls or floor dividing conditioned spaces from unconditioned spaces, provide a flanged duct-segment for installation during the time of wall construction, to provide a tight, hermetic seal.

### 3.2 DUCTWORK AND PLENUM FABRICATION

- A. Duct And Plenum Gages, Joints And Reinforcement
  - 1. Provide fittings, duct, joints and reinforcement per SMACNA HVAC Duct Construction Standards except as otherwise specified. Fabricate to 2" WG, positive or negative, except as otherwise indicated. Where higher pressure class is indicated for a system or portion of a system, fabricate to indicated pressure class per SMACNA HVAC Duct Construction Standards. Minimum Seal Class B. Minimum sheet metal thickness shall be 24 gage.
  - 2. Provide fittings, duct, joints and reinforcement per SMACNA HVAC Duct Construction Standards except as otherwise specified. Fabricate to system fan static pressure scheduled except that minimum Seal Class B shall be provided. Minimum sheet metal thickness shall be 24 gage.
- B. Joint Assembly And Gaskets
  - 1. Assemble standard longitudinal seams and transverse joints with elastomer calk except as otherwise specified.
  - 2. Bolt flanges per SMACNA HVAC Duct Construction Standards unless a different size or spacing is required to mate with equipment flanged connections. Gasket flanged joints at equipment connections and maintenance access locations. Elastomer calk may be used to adhere gaskets to joint face.
- C. Turning Vanes For Right Angle Elbows And Branch Tees
  - 1. Cut individual turning vanes exactly to required length. Cuts shall be neat and square. Turning vanes will not be accepted if they are cut short, are cut on a bias or exhibit jagged cuts.
- D. Square Elbows
  - 1. Provide double vane duct turns in accordance with SMACNA DCS Fig. 2-3 or commercial equivalent products as approved by the ARCHITECT-ENGINEER.
- E. Outlets, Inlets And Supply Duct Branches
  - 1. Install branches, inlets, and outlets in such manner that air turbulence is reduced to a minimum and air volume will be properly apportioned and as follows:
    - a. Where a duct branch is to handle more than 25% of the air handled by the duct main, use a complete 90 degree increasing elbow with an inside radius of 0.75 times branch duct width. Fabricate the size of the leading end of the increasing elbow within the main duct in the same ratio to the main duct size as the ratio of the relative air quantities handled.
    - b. Where a duct branch is to handle 25% or less of the air handled by the duct main, furnish a branch connection of 45 degrees, straight or radius tap-in with volume damper.
  - 2. Where supply ducts have side outlets without branch ductwork, such as registers or grilles, provide turning vanes with manual adjustment.

F. Supply Duct Transitions

1. Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto, unless otherwise indicated.
2. Where equipment is indicated in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment, unless otherwise indicated.

G. Tee Connections

1. Construct tap-ins per SMACNA HVAC Duct Construction Standards Fig. 2-6, unless otherwise indicated.

H. Access Openings And Doors

1. Provide insulated access doors and panels in insulated ductwork. Fabricate access doors and panels in ductwork per SMACNA (HVAC Duct Construction Standards)(Round Industrial Duct Constructions Standards)(Rectangular Industrial Duct Constructions Standards) for the following locations:
  - a. Upstream and downstream from coils.
  - b. Adjacent to fire dampers at the fusible link.
  - c. At controls or items requiring periodic inspection, adjustment, maintenance or cleaning.
  - d. Where indicated.
2. Size access openings minimum 10 by 12 inches unless precluded by duct dimensions.
3. Make duct access provisions suitable for commercial practice duct cleaning methods utilizing vacuum devices. Space access openings with a frequency and at points, which will permit ready access to duct with no duct or insulation cutting. Where access through an air diffusion device or through access doors is not available at a specific point, provide 8 inch diameter 16 gage access plates at not more than 10 foot centers. Where duct is insulated and vapor sealed, provide mastic seals around circumference of access. When access plate is in place and insulated, provide external identification of location.

I. Round Duct Requirements

1. Provide duct, fittings, joints and reinforcement per SMACNA HVAC Duct Construction Standards for pressures up to 2" WG positive or negative. For pressures greater than 2" WG negative fabricate per SMACNA Round Industrial Duct Construction Standards. Round duct connections to main shall be:
  - a. 45 degree lateral.
  - b. Combination tee.
  - c. 2-way "Y".
  - d. Conical tee.

### 3.3 DUCT AND EQUIPMENT SUPPORT SYSTEM

#### A. General

1. Select and provide duct and equipment support system per SMACNA HVAC Duct Construction Standards. After system start-up, replace or otherwise alleviate condition of any duct support element which vibrates.
2. Attach hot rolled carbon steel, prime coated hanger rods, angles, and straps to beam clamps, concrete inserts, and masonry anchors and fasteners per SMACNA HVAC Duct Construction Standards. Set inserts and anchors in conjunction with other Trades. Lugs welded to ducts are not acceptable as sole supports. Powder actuated fasteners into steel or concrete, welded studs, C-clamps, and friction clamps are not acceptable.
3. Do not hang ductwork or equipment from roof deck, piping, other ducts or equipment.
4. Provide not less than one set of two vertical support elements for each point of support and each length of duct. Install supports on sides of duct turns, branch fittings and transitions. Cross-brace hangers vertically and laterally to eliminate sway.
5. Support rectangular ducts in sizes to 36 inches by strap type hangers attached at not less than three places to not less than two duct surfaces in different planes or by trapeze hangers. Perforated strap hangers are not acceptable. Support rectangular ducting 36 inches and larger with trapeze hangers.
6. Use angle iron "V" construction supports or similarly rigid construction for vertical ducting which needs lateral support. Anchor downcomers to building to prevent swaying due to functional operation of any discharge grille directional device. Where no building element is convenient, multi-point cables, structural elements or angle iron may be used.
7. Where ducts are required to have insulation with a vapor sealed facing, support duct on trapeze hangers. Space hangers far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside of the trapeze. Under no circumstances shall duct hangers penetrate the vapor sealed facing.
8. Where ductwork system contains heavy equipment, excluding air diffusion devices and single leaf dampers, hang such equipment independently of the ductwork with rods or angles sized to support the load.
9. Duct hangers in direct contact with galvanized duct surfaces shall be galvanized steel or black carbon steel painted with zinc rich paint.
10. Allowable loads on purlins or the top chord of jack trusses between panel points shall be such as to produce a moment no greater than the moment produced by a one kip concentrated load at midspan of the purlin or jack truss or by the uniform mechanical (utility) load specified on the DRAWINGS. Loads shall not be supported from the top chord of roof or carrying trusses except at their panel points.
11. When the hanger load exceeds the above limits, provide reinforcing of purlin(s) or additional support beam(s). When an additional beam is used, install beam such that it frames into the roof purlin or jack truss top chord or bears on the roof truss top chord panel point.
12. Limit the location of supporting elements for ductwork and equipment when supported from roof to panel points of the bar joists and limit the allowable load on the bar joist such that the loads produce a moment no greater than the moment produced by one kip load at mid-span of bar joist or by a uniform (utility) load specified on the DRAWINGS.

13. When the hanger load exceeds the above limits, provide reinforcing of the roof bar joists or additional structural support as required. When an additional member is used, support the added member at the panel points. Stabilize member by connection to adjacent roof bar joists.
14. Consider bar joists used for supporting fire protection sprinkler mains, electrical lighting fixtures, electrical power duct or cable tray as fully loaded. Supplemental reinforcing of these bar joists or auxiliary support steel shall be furnished and installed by the CONTRACTOR.
15. Building structure shall not be reinforced except as approved by the ARCHITECT-ENGINEER in writing.

### 3.4 DUCTWORK SPECIALTIES

#### A. Acoustic Lining

1. Install duct liner per SMACNA HVAC Duct Construction Standards.

#### B. Flexible Connections

1. Provide flexible connection between sheet metal work and vibrating equipment per SMACNA HVAC Duct Construction Standards. Flexible materials shall be installed loosely without tension at any point and shall be suitable for temperatures and pressures encountered.
2. Install flexible connections after system air moving devices (fans) are operative and vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkles caused by misalignment or fan reaction; width of surface shall be curvilinear.
3. Furnish flexible connections where ducts cross building expansion joint lines.

#### C. Duct Probe Access

1. Locate access fittings as required and directed under the WORK of SECTION 15999.

#### D. Air Diffusion Devices

1. Aesthetically locate air diffusion devices with respect to lighting, ceiling patterns and masonry bond, unless otherwise dimensioned or approved.
2. Install wall mounted supply registers as indicated.
3. Install devices per manufacturer's published instructions.

#### E. Balancing Dampers

1. Provide balancing dampers at each duct main and branch.

#### F. Fire Dampers And Wall Collars

1. Provide fire wall duct penetrations with a fire damper having a fire rating equal to or exceeding the wall rating and a slip joint located on each side of the wall as near to the face of the wall as practical. Securely fasten fire damper to the wall.

G. Flexible Duct

1. Maximum bends for low pressure duct run-outs to diffusers shall be 90 degrees. Medium pressure duct inlet connections to terminal air units shall be limited to 2 feet of straight run. Flexible duct run for diffuser connection shall be limited to a maximum 5 feet.

H. Sound Stopping

1. Provide effective sound stopping and adequate operating clearance to prevent structure contact where ducts penetrate walls, floors, or ceiling into occupied spaces. "Occupied Spaces" include space above ceilings where no special acoustic treatment of ceiling is provided. Make penetrations finish compatible with surface being penetrated.
2. Provide sleeves or flanged duct segments and angle iron framing at time of wall construction.
3. Pack the space between a duct and the inside of a duct sleeve or a construction surface penetration solid with a mineral fiber wherever ducting passes and through equipment room walls, floors and ceilings connected to occupied spaces; other locations where sleeves of construction surface penetrations occur between occupied spaces.
4. Sound stopping and vapor barrier sealing of duct shafts and floor and wall openings, may be accomplished by packing with properly supported mineral fiber insulation and vinyl mastic or by foaming in place with self-extinguishing, silicone foam and cover with 11 gage sheet metal as specified for ductwork. Make vapor barrier of not less than 1/8 inch thickness of UL Listed vinyl mastic applied to visible and accessible surfaces.

I. Painting

1. Interiors of ducts or construction above ceilings shall not be visible through air diffusion devices. Where interior of duct would be visible, paint the viewed interior flat black as part of the Work under this SECTION.
2. Where construction above ceiling would be visible, provide sheet metal baffle with turned edges suspended from building construction. Size and position of baffle SHALL NOT restrict air distribution design. Paint baffle black as part of the WORK under this SECTION. Where space above ceiling precludes use of baffle construction, paint visible building surfaces flat black as part of the WORK under this SECTION.

### 3.5 FIELD QUALITY CONTROL

A. Structural Integrity And Leakage Tests

1. Structural integrity and leakage testing of air handling systems shall be as systems, or as duct mains and branches.
2. Test complete system after completion of erection. If excessive leakage is found, determine source(s) of leakage, repair and retest.
3. Perform tests for structural integrity and leakage prior to insulation of surfaces, painting and concealment of work in the presence of the ARCHITECT-ENGINEER.
4. Inspect and test systems, as follows:
  - a. Perform systems structural and leakage tests per applicable requirements of SMACNA Duct Construction Standards and HVAC Air Duct Leakage Manual.
  - b. To positive or negative pressures, or both, whichever is normal to the portion of system under test.

B. Systems Acceptance

1. Systems will be acceptable provided:
  - a. No visually apparent mechanical defects exist.
  - b. No audible leakage exists at any point.
  - c. No leakage is perceptible to the hand when placed within 6 inches of a joint.
  - d. Systems have met SMACNA test requirements.
  - e. Fire dampers tested as part of the WORK of SECTION 15999.

C. Test Apparatus And Procedures

1. Test apparatus and procedures shall be per SMACNA NEBB Procedural Standards for Testing, Adjusting and Balancing. Provide filtered blower inlet and automatic safety relief device to protect system. Accuracy of measurement of leakage flow rate shall be certified as within 2% of total leakage flow.

D. Test Report

1. Provide a "Test Report" on systems tested, identified by system or section thereof and containing leak test curves for apparatus used and data pertinent to acceptance requirements.

### 3.6 ADJUSTING AND CLEANING

A. Adjust And Balance Air Distribution Systems

1. Air handling systems balancing and adjustment will be done as part of the WORK under SECTION 15950.

B. Ductwork Cleaning Provisions

1. Protect open ducting from construction dust and debris. Clean dirty assembled ducting by subjecting main and branch interior surfaces to air streams moving at velocities two times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: Filter equipped portable blowers which remain the CONTRACTOR'S property, wheel mounted, compressed air operated, perimeter lances which direct the compressed air and which are pulled in the direction of normal air flow, other means approved by the ARCHITECT-ENGINEER. Compressed air used for cleaning ducting shall be water and oil free. After construction is complete, and prior to acceptance, remove construction dust and debris from exterior surfaces.

END OF SECTION

Revision History	
Date	Rev. No.
A	0
B	0
C	0
D	0
E	0
F	0
02-19-09	0

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